Phenotypic flexibility in the basal metabolic rate of Laughing Doves (*Streptopelia senegalensis*) in response to short-term thermal acclimation

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DECLARATION

I declare that this dissertation is my own unaided work. It is being submitted for the Degree of Master of Science in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.

Kinesh Chetty

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ABSTRACT

Phenotypic flexibility in basal metabolic rate (BMR) in response to short-term thermal acclimation was assessed in the Laughing Dove (*Streptopelia senegalensis*), a common resident bird species distributed throughout most of southern Africa. I hypothesised that *S. senegalensis* would display flexibility in BMR over short time scales and that this flexibility would be reversible. Additionally, I hypothesised BMR to be repeatable, and that changes in BMR would be correlated with changes in organ mass. I tested these hypotheses by measuring BMR in three groups of 10 birds before and after a short-term (21 day) thermal acclimation period to one of three air temperatures (10^{o}, 22^{o} & $35^{o}C$). After acclimation the three temperature groups were randomly divided and reverse-acclimated for another 21 days to one of the two thermal environments not yet experienced. After this reverse-acclimation period BMR was measured again. The dry masses of the stomach, kidney, heart, intestines, liver and pectoral muscles of acclimated birds were used to determine possible mechanistic correlates of BMR adjustments. Additionally, by monitoring BMR every 4-6 days during cold ($10^{o}C$) and heat ($35^{o}C$) acclimation I was able to assess the temporal dynamics of adjustments in BMR in response to short-term thermal acclimation.

BMR was both flexible and reversible in *S. senegalensis* as a consistent relationship between BMR and acclimation air temperature was observed after acclimation and reverse-acclimation. BMR increased with decreasing acclimation temperature. Furthermore, a significant proportion (25%) of the observed variation in BMR was repeatable in the $22^{o}C$ group in spite of the change in BMR induced by thermal acclimation. The mechanistic correlate of BMR adjustment in *S. senegalensis* appears to

be metabolic intensity and not organ size, as the only organ to show a significant increase in size was the intestine of the acclimated 10°C group, which was significantly heavier than the intestine of the 22°C group. BMR also decreases in response to the reduction of flight and/or exercise. Since this reduction was not accompanied by a correlated change in organ mass or body mass, the reduction in BMR as a response to captivity appears to be linked to metabolic intensity of the organs and skeletal muscles.

In *S. senegalensis* adjustments in BMR occur during the first 30 days of captivity and thermal acclimation. The response in BMR to acclimation temperature is clearly evident as BMR of the heat-acclimated group was significantly lower than the cold-acclimated group after 21 days. During the response period, which lasts approximately 30 days, BMR adjusts as a mechanism to offset the costs of thermoregulation and habituation to captivity while other metabolic parameters such as body mass, body temperature, and minimum wet thermal conductance adjust to captivity and the thermal environment. After 30 days BMR of the cold and heat-acclimated groups converge on 0.68W, indicating that once the associated metabolic parameters adjust and stabilize in response to the thermal environment, BMR continues to adjust to captivity.

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List of Abbreviations:

BMR: Basal metabolic rate

CE: Constant environment

C_{wet}: Minimum wet thermal conductance

M_b: Body mass

MR: Metabolic rate

T_a: Ambient air temperature

T_{acc}: Acclimation air temperature

T_b: Body temperature

T_{lc}: Lower critical limit of thermoneutrality

TNZ: Thermoneutral zone

VO_2: Oxygen consumption

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